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Effect of using autotransfusion system on cost in open-heart surgery

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Abstract

Aim: The high cost of autotransfusion systems can limit its usage. In our study, we aimed to compare the cost of open-heart surgery cases with and without the use of an autotransfusion system in our hospital.

Material and Method: Of the isolated coronary artery bypass grafting (CABG) cases performed, 22 cases (Group 1), in which the autotransfusion system was used and 22 cases (Group 2), in which the autotransfusion system was not used, were retrospectively determined. In particular, the use of blood and blood products that will affect costs, the amount of drainage for the first 24 hours, mechanical ventilator, intensive care-hospitalization periods, preoperative hematocrit and postoperative hemotocrit values and demographic data were obtained. Costs between groups were calculated and compared taking into consideration the current prices.

Results: In Group 1, the use of erythrocyte suspension (median: 2.0 - 3.0; p = 0.003) and intensive care periods (mean: 1.77 - 2.55; p = 0.046) were found to be significantly lower than Group 2. There were no significant differences between the groups in terms of other variables. When calculating, it was determined that in Group 1, the cost for each case was more than 1050 TL.

Discussion: The autotransfusion system is expensive and can provide a reduction in total cost with the benefits it provides. However, it is seen that this does not reduce the total cost enough to save its own costs when considering the current expenses. Compared to the short-and long-term benefits they provide, meeting this cost seems to be tolerable with case selection.

Keywords

Autotransfusion; Open heart surgery; Cost analysis

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Introduction

The process of giving the patient's blood collected during the surgery back to the patient was first reported by Blundell in 1818 [1]. Even though the focus was on autotransfusion, due to the fact that blood banks were not developed at the time and homologous blood transfusion was not widely available, the issue was avoided with the increased number of blood centers. However, autotransfusion has again become the center of attention with the discovery of the harms of homologous blood transfusions [2]. Thus, it has been recommended to reduce the use of homologous blood as much as possible by showing these harmful effects in open-heart surgery in various studies [3,4,5]. The negative effects of homologous blood transfusion include hemolytic reactions (high antibody titer, intra- or extravascular hemolysis), febrile reactions, bacterial reactions, the risk of infectious disease (viral hepatitis, cytomegalovirus, Epstein-Barr virus, syphilis, herpes group, malaria AIDS, etc.) [6].

The methods used to reduce the need for blood transfusion can be listed as follows: (a) the patient's own blood is collected in the preoperative period and stored after certain procedures, (b) phlebotomy and volume replacement during early surgery, (c) giving the patient's blood back to him/her using autotransfusion (Cell Saver) during surgery [7].

Today, the most frequently used methods of autologous blood transfusion during surgery are simple aspiration system (Solcotrans), semi-automatic system (Haemonetics, Cell Saver) and continuous autotransfusion system (CATS) [8]. The most important advantage of the autotransfusion system is that it creates a fast and high level of hematocrit and provides a high rate of fat and particle removal by washing the blood collected from the patient [9]. This is of great benefit in patients with high bleeding rates to reuse the lost blood.

Furthermore, the known advantages of autotransfusion include the elimination of the possibility of blood incompatibility, and the absence of the risks of alloimmunization, immunosuppression and infection [10,11]. The autotransfusion method can be used in vascular, orthopedic, hepatic, gastrointestinal, and some other surgical branches in addition to cardiac surgery [12-14]. Open-heart surgery is a surgery with a high risk of bleeding. Therefore, autotransfusion systems gain particular importance because blood can remain out of use in the heart-lung machine lines and reservoirs at the end of the surgery. On the other hand, the high cost of autotransfusion systems narrows and limits their areas of use.

Autotransfusion reduces the need for blood and blood products [4,5]. Although costs are limiting its usage, it may have a positive effect on the total hospital cost by reducing the use of blood and blood products. Based on this basic principle, in this study, we aimed to compare the total hospital costs of the cases by analyzing them according to the use of the autotransfusion system.

Material and Methods

Between July 2017 and December 2018, patients who were diagnosed with coronary artery disease and decided to have coronary artery bypass grafting (CABG) in our Cardiovascular Surgery Department were retrospectively identified. Twenty-two patients (Group 1) for whom the autotransfusion system (Xtra, LivaNova, London, UK) was used, and 22 patients (Group 2) for whom the autotransfusion system was not used, were included in the study. Redo cases, cases that needed to be taken urgently and were given antiplatelet loading therapy or using it routinely, patients with known platelet and coagulation disorders were excluded from the study. Cases in which cardiac chambers were opened, aortotomy was performed, and cases reoperated due to surgical bleeding, and cases not using left internal mammary artery were not included in the study.

The study was approved by the local ethical Committee of Canakkale Onsekiz Mart University (COMU) (The chairperson of the ethics committee; Prof.Dr. Coşkun Sılan. File registry/decision/no: KAEK-27/2020-E.200009218).

The variables such as age and gender of the patients, number of bypass surgeries undergone, postoperative 24-hour drainage amount, mechanical ventilation (MV) duration, duration of intensive care stay, total hospital stay, preoperative Hct and postoperative Hct values, number of blood and blood products used (erythrocyte suspension (ES), complete blood, fresh frozen plasma (FFP), platelet suspension) were identified. The difference in cost arisen according to the values of the variables that differed significantly between the groups was calculated according to the current Social Security Institution (SSI) prices.

Statistical analysis

The data of the study were analyzed with the statistics package program SPSS, IBM, Chicago, USA 20.0 version. The data were presented using number, percentage, mean, standard deviation, median, minimum and maximum values. The Mann-Whitney U test was used as a nonparametric test according to the results of the normal distribution test. $P < 0.05$ was considered statistically significant.

Results

There was no difference in age and gender of the patients in both groups (Table 1). The average number of bypasses was determined as 3 (range: 2-5) in the groups. There was no significant difference between the groups in terms of the whole blood, (fresh frozen plasma) FFP, MV duration, drainage, preoperative Hct, postoperative Hct values, and hospitalization times. Intensive care period ($p = 0.046$), ES ($p = 0.003$) values were found to be significantly lower in Group 1. The blood volume given back to the patient from the Group 1 autotransfusion system was determined to be an average of 640cc (min: 200, max: 1400).

The unit price list of blood and blood products according to the SSI current price list (June 2020) is shown in Table 2.

Autotransfusion Set (XTRA, LivaNova) unit price (June 2020): 1.200 TL + VAT (8%) = 1296 TL

1-unit ES SSI unit price (June 2020): 239.45 TL + 1 blood transfer set: 6 TL = 245.45

Group 1 cost difference = - 1296 + 245.45 = - 1050.55 TL

Discussion

Blood preservation techniques are one of the subjects that are known to be important and have been tried to be applied in open-heart surgery. Inconvenient situations related to the use of blood products are tried to be avoided in cardiac surgery cases as in all other surgeries. Autotransfusion systems are

Table 1. Distribution of the variables

	Group 1 (n:22) Median (Min – Max)	Group 2 (n:22) Median (Min – Max)	P
Gender (%)	F: 27.3 M:72.7	F:36.4 M:63.6	0.522
Age (Year)	64(45-87)	68 (46-86)	0.760
CABGx	3(2-5)	3(2-5)	0.785
ES (Units)	2.0(0-3)	3.0(1-5)	0.003
Whole Blood (Units)	2.0(1-3)	2.0(1-4)	0.065
TDP (Units)	2.0(2-3)	2.0(2-3)	0.346
Thrombocyte	0	0	
MV Duration (Hour)	7(4-15)	10(6-17)	0.052
Drainage (24h)	500(150-1150)	600(300-1050)	0.083
HCT preop	39(36-43)	39(35-45)	0.943
HCT postop	29(26-34)	28.5(26-32)	0.111
Intensive Care (Days)	1.77 / 2(1-4)	2.55 / 2(1-6)	0.046
Hospitalization (Days)	6(4-8)	6(4-9)	0.389

Table 2. Blood products, blood transfer set price list (June 2020)

NO	SUT CODE	SUT NAME	SUT MEDULA UNIVERSITY PRICE (TL)	KIZILAY BUYING PRICE (COST) (TL)
1	705350	Apheresis thrombocyte suspension	361.9	361.9
2	705370	Erythrocyte suspension	102.52	None
3	705371	Erythrocyte suspension received from KIZILAY	239.45	239.45
4	705440	Fresh frozen plasma	76.11	76.11
5	705442	Pooled platelet suspension-four units	416.95	416.95
6	705420	Whole Blood	63.36	None
OR1845 (EK: RG-21/04/2015-29333)		**SET, PERFUSER**		
OR1850		SET, PUMP, TO GIVE BLOOD		6.00

Study	Klein	Weltert	Ours	Shander and Weltert
Country	Britain	Italy	China	Developed countries (Italy, Britain, America, Switzerland, Austria)
Year	2007	2012	2014	2012(Italy), 2007(others)
Cases	94	537	72	/
Bleeding-risk of surgery	Low	Low and high	High	High
Price of allogeneic RBC ($/U)[A]	219	201	22.8	203
Quantity of autologous RBC transfusion (U)[B]	/	1.95	4.09	4.09
Price of autologous blood transfusion ($)[C]	153	258	243.9	258
Cost of reduced ($)[D]	-103	134	-150.6	572.3
Cost-effectiveness	No	Yes	No	Yes

Data represent average quantity or cost per case. " / " = No data.
[D] = [A]×[B] − [C] or from the report (Klein). Cost-effectiveness, [D]>0 = yes, [D]<0 = no.

Figure 1. Cost- effectiveness of Cell Saver in different studies [16]

systems developed to provide benefits in this regard by making the patient's blood reusable. However, they are costly devices due to their many mechanisms, and this cost can limit their usage.

Reducing the use of blood products is expected to have a positive effect on both the adverse conditions that may develop in the patient and the total cost. Considering the major costs of blood products, this reduction could create a significant change in the total cost. In our study, which we planned on this basic forecast, we aimed to find the total cost analysis computationally. This is a calculation that shows the early cost, and the calculations on the long-term cost may be much different (for example, the long-term treatment cost of an infection transmitted by blood products transfusion).

While making this determination, all patients' files were examined one by one, as the blood product may be registered in the system even if the blood product was not used for the patient after the blood product was checked out from the blood bank, and this may be misleading. Therefore, the blood products used were determined precisely by examining the epicrisis notes, intensive care follow-up treatment charts, service follow-up forms and blood product transfusion forms.

In the package pricing, the factors such as intensive care, hospital admission, mechanical ventilator durations that could indirectly affect the costs were determined to be a source for other studies.

While determining the patients, all surgical differences that may affect bleeding, and especially patients who were given medication that would increase bleeding, were excluded from the study. Only patients who underwent bypass surgery were included in the study, as this may alter bleeding and therefore the need for blood products. The differences between groups that could affect the use of blood products were determined by identifying the preoperative and postoperative Hct values.

There was no difference in age and gender of the patients in both groups (Table 1). The average number of bypass surgeries was 3 (range: 2-5).

There was no significant difference between the groups in terms of age, gender, number of bypass surgeries, whole blood, FFP, MV duration, drainage, preoperative Hct, postoperative Hct values, and hospitalization times. ES (p = 0.003) intensive care period (p = 0.046) was found to be significantly lower in Group 1. When this difference in the ES value was compared with the median values (2.0 – 3.0), it was seen that 1 less erythrocyte suspension was used for each patient in Group 1. Although there is a significant difference between the groups in terms of the intensive care hospitalization period, it does not appear to have a direct effect on the cost due to the package price application. However, it is known that the psychological effects of staying in the intensive care unit for a long time increase the material cost and the workload of the staff. In addition, thrombocyte suspension was never used in both groups. We think that this situation is related to the exclusion criteria.

According to the data obtained, the cost difference between Group 1 and Group 2 = - 1296 + 245.45 = - 1050.55 TL.

The result obtained is a computational result. There was no cost difference according to statistically significant parameters.

According to this calculation, the difference of 1296/245.45 = 5.28 ES should be achieved in order for the autotransfusion set to meet its own cost in Turkey. In the meta-analysis study by Carless et al., it was shown that the use of autotransfusion reduces the need for ES up to 0.68 units per patient [15].

Xie Z showed that the cost can be different depending on the difference in the unit price in different countries [16]. For example, the cost of 1-unit ES in China is $22.8, while it is $219 in England and $201 in Italy, respectively. In Turkey, 1-unit ES is $33 ($1 = 7.25 TL; July/2020). In the same study, although there was an overuse of 4.09 units of ES per patient with autotransfusion in China, the cost analysis was negative (-150.6 $). In addition, the price of 1-unit red blood cell (RBC) in Italy is $201, and a profitability of $134 was seen in the cost analysis with 1.95 unit more RBC usage per patient (Figure 1) [16].

It is seen that the cost analysis can give different results based on the unit prices in the countries. In our study, we aimed to find the cost effectiveness of the use of autotransfusion system in our country. As a result, it was seen that autotransfusion systems provide a partial reduction of costs at an early stage with 1-unit reduction in RBC use, but cannot generate profitability. However, this is just a computational analysis of the initial cost. Long-term results may be completely different, especially considering the cost of diseases that can only be transmitted through blood.

Should autotransfusion systems be used in all cases when the cost is ignored? Alexander B et al. [5] argued that autotransfusion systems should be used in all open-heart surgery cases; on the contrary, there are studies showing that the routine use of these systems is ineffective and causes an additional cost burden [17]. Seyfried T. et al, on the other hand, pointed out that the risk of bleeding may occur with arrhythmia, decrease in the number of platelets and dilution coagulopathy that can result from decreased potassium levels with washing, and emphasized the importance of case selection [18]. In another study, it was shown that such complications do not occur, and that cost effectiveness is achieved with a bleeding volume of 600-1000 ml [19]. There are also some other studies stating that clots can develop in the autotransfusion system [20]. All of these show the possible drawbacks of autotransfusion systems and the importance of suitable case selection apart from cost.

Conclusion

The importance and benefits of blood preservation in open heart surgery have been shown in many studies. Although the autotransfusion system is expensive, it can provide a reduction in total cost due to the benefits it provides. Given the current prices in Turkey, it was seen that these systems cannot provide a reduction in the total cost enough to meet their own costs. Compared to the short- and long-term benefits they provide, meeting this cost seems to be tolerable with case selection.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

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